Accelerator Systems Cost Estimate

Baseline/guideline budget

- Accelerator Systems Cost Overview
- Instrumentation
- Beam Commissioning & Accelerator Physics
- Hardware Commissioning

Enhanced budget

Accelerator Systems Cost OVERVIEW

		FY04	FY05	FY06	FY07	FY08	FY09
Labor Count	FTE	2.6	7.1	14.6	18.0	17.2	15.4
Labor Cost	$k03	502	1314	2410	2910	2676	2380
Travel	$k03	27	74	146	185	169	154
Materials & Services	$k03	90	330	760	865	690	690
TOTAL COSTS (escalated)							
Instrumentation	$k	300	744	1,733	2,048	1,953	1,897
Beam Comm & Acc Phys	$k	227	570	1,366	1,896	1,895	1,952
Hardware Commissioning	$k	111	509	525	512	249	0
GRAND TOTAL	**$k**	**638**	**1,823**	**3,623**	**4,457**	**4,098**	**3,850**
Guideline	$k	635	1,820	3,620	4,460	4,100	3,840

Travel budget allows $10k/yr for each FTE

Burdens are included in travel and M&S costs shown

Instrumentation

Instrumentation program consists of 3 initial instrument systems + additional instrumentation (as yet unidentified)

M&S budget includes:

- 1 prototype tune measurement system
- full complement of 4 TAN luminosity monitors
- 2 longitudinal density monitors

All devices will be delivered & installed for routine LHC operations

Delivered systems are integrated and complete, up to & including a software interface into the LHC control system (details?)

Instrumentation OVERVIEW

		FY04	FY05	FY06	FY07	FY08	FY09
Labor count							
Tune feedback	FTE	.5	.5	1.6	1.8	1.0	.0
Luminosity monitor	FTE	.6	1.4	2.4	1.8	1.0	.0
Longitudinal density monitor	FTE		.5	1.6	2.5	2.4	1.0
Additional Instrumentation	FTE				.4	2.3	4.9
Materials & Services							
Tune feedback	$k03	40	70	180	180	50	0
Luminosity monitor	$k03	40	150	300	250	100	0
Longitudinal density monitor	$k03		40	200	300	200	50
Additional Instrumentation	$k03				70	300	600
Labor cost	$k03	202	424	860	960	976	880
Travel	$k03	10	17	46	60	59	59
Materials & Services	$k03	80	260	680	800	650	650
TOTAL COST							
Constant dollars	$k03	292	701	1,586	1,820	1,685	1,589
3.00%	$k	300	744	1,733	2,048	1,953	1,897

Instrumentation LABOR

Labor count		FY04	FY05	FY06	FY07	FY08	FY09
Tune feedback							
Scientist/Engineer	FTE	.5	.5	1.0	.8	.5	
Post Doc/Student	FTE			.6	1.0	.5	
Designer/Technician	FTE						
Luminosity monitor							
Scientist/Engineer	FTE	.5	.7	1.0	.8	.5	
Post Doc/Student	FTE			.7	1.0	.5	
Designer/Technician	FTE	.1	.7	.7			
Longitudinal density monitor							
Scientist/Engineer	FTE		.5	.8	1.0	.8	.5
Post Doc/Student	FTE			.5	1.0	.8	.5
Designer/Technician	FTE			.3	.5	.8	
Additional Instrumentation							
Scientist/Engineer	FTE				.4	1.1	2.4
Post Doc/Student	FTE				.0	1.2	2.5
Designer/Technician	FTE				.0	.0	
SUB-TOTALS							
Scientist/Engineer	FTE	1.0	1.7	2.8	3.0	2.9	2.9
Post Doc/Student	FTE	.0	.0	1.8	3.0	3.0	3.0
Designer/Technician	FTE	.1	.7	1.0	.5	.8	.0
TOTAL LABOR	FTE	1.1	2.4	5.6	6.5	6.7	5.9

Instrumentation

The effort required on (and the scope of) the initial 3 instruments is relatively well understood:

1) Tune and Chromaticity Feedback
- R&D is a level of effort task
- ramps up to 1 FTE in 2007
- M&S includes one prototype system (installed)

2) Luminosity Monitor
- eight 4-channel devices built in FY2005-2006
- for use at all 4 IRs (TAN locations but not TAS)

Instrumentation

3) Longitudinal Density Monitors
- 1 installed in each ring
- initial support from LBNL internal LDRD funds
- first LARP support in FY2005
- burden of the development work in FY2006-2007
- M&S cost sharing with CERN may be necessary

Additional Instruments
- in later years some of the constant level of effort becomes available for development of additional instruments
- up to 50% of the effort from post-docs and students
- specific cost estimates are not yet possible

Beam Commissioning and Accelerator Physics

Beam Commissioning
- significant work begins in FY 2006 with the injection test, including beam through US built IR 8 magnets
- work in FY2005-2006 is focused on preparations: real responsibility requires early integration into CERN teams
- circulating beam commissioning from FY2007-2009
- LHC will be difficult to bring to full operational parameters
- about 50% of the effort will involve post-docs

A rough estimate of the fraction of BC&AP work in the US and at CERN is shown below

BC&AP cost overview

		FY04	FY05	FY06	FY07	FY08	FY09
BEAM COMMISSIONING							
Labor count	FTE	.5	1.6	4.0	6.5	6.5	6.5
Cost sub-totals							
Labor	$k03	100	270	650	1,050	1,000	1,000
Travel	$k03	5	16	40	65	65	65
FUNDAMENTAL ACCELERATOR PHYSICS							
Labor count	FTE	0.5	1.1	3	3	3	3
Cost sub-totals							
Labor	$k03	100	220	500	500	500	500
Travel	$k03	5	11	30	30	30	30
TOTAL COST							
Not escalated	$k03	220	537	1,250	1,685	1,635	1,635
3.00%	$k	227	570	1,366	1,896	1,895	1,952

BC&AP labor details

		FY04	FY05	FY06	FY07	FY08	FY09
BEAM COMMISSIONING							
Labor count							
At a U.S. Lab	*FTE*	*.5*	*1.1*	*2.0*	*1.0*		
At CERN	*FTE*		*.5*	*2.0*	*5.5*	*6.5*	*6.5*
Scientist/Engineer	FTE	.5	1.1	2.5	4.0	3.5	3.5
Post Doc/Student	FTE		.5	1.5	2.5	3.0	3.0
SUB-TOTAL	FTE	.5	1.6	4.0	6.5	6.5	6.5
FUNDAMENTAL ACCELERATOR PHYSICS							
Labor count							
At a U.S. Lab	*FTE*	*.5*	*1.1*	*2.0*	*2.0*	*2.0*	*2.0*
At CERN	*FTE*			*1.0*	*1.0*	*1.0*	*1.0*
Scientist/Engineer	FTE	.5	1.1	2.0	2.0	2.0	2.0
Post Doc/Student	FTE			1.0	1.0	1.0	1.0
SUB-TOTAL	FTE	.5	1.1	3.0	3.0	3.0	3.0
BEAM COMMISSIONING + FUNDAMENTAL ACCELERATOR PHYSICS							
Labor count	FTE	1.0	2.7	7.0	9.5	9.5	9.5

Beam Commissioning and Accelerator Physics

Accelerator Physics

- early work concentrates on problems related to IR upgrades
- effort increases in FY2006 and beyond, as LHC begins operations
- about 1/3 of the effort is by post-docs

Hardware Commissioning

Major activities begin in FY2005, when US built IR systems in IR8 L and IR2 R are commissioned (without beam)

Commissioning of 6 more regions with US components takes place in FY2006, and the final 2 regions in FY2007

Additional hardware commissioning lessons will be learned with the significant heat-loading from p-p collisions, in operation

A modest M&S budget is also included

Hardware Commissioning

		FY04	FY05	FY06	FY07	FY08	FY09
Labor count							
At a U.S. Lab	FTE	.5	.5				
At CERN	FTE		1.5	2.0	2.0	1.0	
Scientist/Engineer	FTE	.5	2.0	2.0	2.0	1.0	
Labor count	FTE	.5	2.0	2.0	2.0	1.0	.0
Labor cost	$k03	100	400	400	400	200	0
Travel	$k03	8	30	30	30	15	0
Materials & Services	$k03		50	50	25		
TOTAL COST							
Not escalated	$k03	108	480	480	455	215	0
3.00%	$k	111	509	525	512	249	0

ENHANCED Accelerator Systems Budget

Base or Guideline Budget

		FY04	FY05	FY06	FY07	FY08	FY09
Labor Count	FTE	2.6	7.1	14.6	18.0	17.2	15.4
Labor Cost	$k03	502	1314	2410	2910	2676	2380
Travel	$k03	27	74	146	185	169	154
Materials & Services	$k03	90	330	760	865	690	690
TOTAL COSTS (escalated)							
Instrumentation	$k	300	744	1,733	2,048	1,953	1,897
Beam Comm & Acc Phys	$k	227	570	1,366	1,896	1,895	1,952
Hardware Commissioning	$k	111	509	525	512	249	0
GRAND TOTAL	**$k**	**638**	**1,823**	**3,623**	**4,457**	**4,098**	**3,850**
Guideline	$k	635	1,820	3,620	4,460	4,100	3,840

Enhanced Budget

		FY04	FY05	FY06	FY07	FY08	FY09
Labor Count	FTE	4.9	8.6	15.8	25.7	24.4	23.0
Labor Cost	$k03	850	1570	2650	4080	3700	3390
Travel	$k03	52	102	202	402	366	309
Materials & Services	$k03	150	470	1240	1255	630	640
TOTAL COSTS (escalated)							
Instrumentation	$k	746	1187	2544	3418	2659	2663
Beam Comm & Acc Phys	$k	227	576	1403	2527	2535	2518
Hardware Commissioning	$k	111	509	525	512	249	0
GRAND TOTAL	**$k**	**1,083**	**2,272**	**4,472**	**6,457**	**5,444**	**5,181**
Guideline	$k	635	1,820	3,620	4,460	4,100	3,840
Guideline - total		-448	-452	-852	-1,997	-1,344	-1,341

ENHANCED Budget

Instrumentation

- increase Tune meter labor to 1 scientist + 1 postdoc, FY04-07
- enhance Lumi monitor labor and M&S
- move Longitudinal Density Monitor schedule 1 year earlier
- adjust "Additional Instrumentation" for a flatter labor profile

Beam Commissioning & Accelerator Physics

- increase travel from $10k/yr to $30k/yr for CERN labor
- return labor from 9.5 to 12 FTEs in FY07 and beyond

Hardware Commissioning

- no change

ENHANCED Budget
Instrumentation

		FY04	FY05	FY06	FY07	FY08	FY09	FY04-07	Base
Labor count									
Tune feedback	FTE	2.0	2.0	2.0	2.0	1.0	.0	8.0	4.4
Luminosity monitor	FTE	.6	1.2	1.4	3.2	2.7	.0	6.4	6.2
Longitudinal density monitor	FTE		.7	3.0	4.5	3.7	.0	8.2	4.6
Additional Instrumentation	FTE			.4	2.0	4.0	11.0	2.4	.4
Materials & Services									
Tune feedback	$k03	40	70	180	180	50	0	470	470
Luminosity monitor	$k03	60	310	570	135	45	0	1,075	740
Longitudinal density monitor	$k03	40	20	370	805	95		1,235	540
Additional Instrumentation	$k03			40	70	400	600	110	70
Labor cost	$k03	550	680	1,100	1,730	1,600	1,540	4,060	2,446
Travel	$k03	34	39	68	117	104	90	258	133
Materials & Services	$k03	140	400	1,160	1,190	590	600	2,890	1,820
TOTAL COST									
Constant dollars	$k03	724	1,119	2,328	3,037	2,294	2,230	7,208	4,399
3.00%	$k	746	1,187	2,544	3,418	2,659	2,663	7,895	1,820

ENHANCED Budget Instrumentation

Tune Feedback

- INTEGRATED effort is almost twice the baseline (4.4 to 8.0 FTE-years)

Lumi Monitor

- essentially the same labor (with some re-distribution)
- additional $435k in M&S

Longitudinal Density Monitor

- INTEGRATED effort considerably higher (4.6 to 8.2 FTE-years)
- M&S is $695k larger
- 1 year earlier

ENHANCED Budget Instrumentation

The instrumentation deliverables are clearly defined (eight 4 channel lumi monitors, et cetera)

But the exact CERN/US split of funding for M&S for Construction still needs refinement, via cost estimate iterations, and the response of the CERN-US Committee

Enhanced funding would deliver more, better, sooner

Summary

The guideline budget is a viable basis to

- deliver 3 initial instruments
- segue to additional instruments
- participate as equal team members in beam commissioning
  (goal: 1 US physicist on every shift)
- exploit and develop unique US capabilities in fundamental AP
- support IR upgrade activities
- provide hardware commissioning of US deliverables

But it

- defers and limits US funded instrumentation deliverables
- creates a momentum-breaking hiatus in AP (& other) activities
- limits the presence at CERN, and early luminosity assistance